

IN THE CLAIMS:

The text of all pending claims, (including withdrawn claims) is set forth below. Cancelled and not entered claims are indicated with claim number and status only. The claims as listed below show added text with underlining and deleted text with ~~striketrough~~. When strikethrough cannot easily be perceived, or when five or fewer characters are deleted, [[double brackets]] are used to show the deletion. The status of each claim is indicated with one of (original), (currently amended), (cancelled), (withdrawn), (new), (previously presented), or (not entered). Please AMEND claims 3-7, 11, 13, 14, 19, 25, 26, 30, 31, 32, 33, 34, 35, 36, and 39 and CANCEL claims 1, 2, 8, 17, 18, 23, 24, 25, 28 and 29 without prejudice or disclaimer in accordance with the following:

1. (cancelled)
2. (cancelled)
3. (currently amended) The electrolyte for the lithium-sulfur battery of claim ~~434~~, wherein a difference in sulfur solubility between said first component solvent and said second component solvent is more than 20mM.
4. (currently amended) The electrolyte for the lithium-sulfur battery of claim ~~434~~, wherein said second component solvent and said third component solvent are mixed in a ratio of 1:1.
5. (currently amended) The electrolyte for the lithium-sulfur battery of claim ~~434~~, wherein said first component solvent is at least one selected from a group consisting of benzene, fluorobenzene, toluene, trifluorotoluene, xylene, cyclohexane, tetrahydrofurane, and 2-methyl tetrahydrofurane.

6. (currently amended) The electrolyte for the lithium-sulfur battery of claim 434, wherein said second component solvent is at least one selected from a group consisting of cyclohexanone, ethanol, isopropanol, dimethyl carbonate, ethylmethyl carbonate, diethyl carbonate, methylpropyl carbonate, methyl propionate, ethyl propionate, methyl acetate, ethyl acetate, propyl acetate, dimethoxy ethane, 1,3-dioxolane, diglyme (2-methoxyethyl ether), and tetraglyme.

7. (currently amended) The electrolyte for the lithium-sulfur battery of claim 434, wherein said third component solvent is at least one selected from a group consisting of ethylene carbonate, propylene carbonate, γ -butyrolactone, and sulforane.

8. (cancelled)

9. (previously presented) The electrolyte for the lithium-sulfur battery of claim 35, wherein said additive gas is at least one selected from a group consisting of CO_2 , SO_2 and N_2O .

10. (previously presented) The electrolyte for the lithium-sulfur battery of claim 35, wherein said additive gas is substantially between 0.2% and 10% by weight of the electrolyte.

11. (currently amended) The electrolyte for the lithium-sulfur battery of claim 434, wherein said electrolyte salt is at least one selected from a group consisting of lithium hexafluorophosphate, lithium tetrafluoroborate, lithium hexafluoroarsenate, lithium perchlorate, lithium trifluoromethane sulfonylimide, and lithium trifluorosulfonate.

12. (previously presented) The electrolyte for the lithium-sulfur battery of claim 11, wherein a concentration of said electrolyte salt is substantially between 0.5 M and 2.0 M.

13. (currently amended) A lithium-sulfur battery comprising:
a negative electrode comprising a negative active material selected from a group consisting of lithium metal, lithium-containing alloy, a combination electrode of lithium/inactive sulfur, a compound that reversibly intercalates a lithium ion, and a compound that reversibly redoxides with the lithium ion at a surface;

an electrolyte comprising:

a first component solvent with a sulfur solubility greater than or equal to 20 mM;

a second component solvent with a sulfur solubility less than 20 mM ~~and greater than 0.5 mM~~;

a third component solvent with a high dielectric constant and a high viscosity, and an electrolyte salt; and

a positive electrode comprising a positive active material comprising at least one sulfur-based material selected from a group consisting of sulfur element, Li_2S_n ($n \geq 1$), organic sulfur compound and carbon-sulfur polymer $((\text{C}_2\text{S}_x)_n$ where $x=2.5$ to 50 and $n \geq 2$), and electrically conductive material,

wherein said electrolyte further comprises an additive to prevent the formation of dendrite on a surface of said negative electrode.

14. (currently amended) An electrolyte for use in a lithium-sulfur battery, comprising:
a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;
a high dielectric solvent having a high dielectric constant; and
an electrolyte salt,

wherein said mixture comprises a first solvent with a sulfur solubility greater than or equal to 20 mM and a second solvent with a sulfur solubility less than 20 mM,

the first solvent is substantially between 5% and 30% by volume of the electrolyte,

the second solvent is substantially between 20% and 70% by volume of the electrolyte,

and

said high dielectric solvent is substantially between 20% and 70% by volume of the electrolyte.

15. (original) The electrolyte of claim 14, wherein said mixture comprises first and second solvents, wherein a relative amount of the first and second solvents is determined in accordance with a relative amount of the sulfur and the sulfur compounds.

16. (original) The electrolyte of claim 15, wherein a relative amount of the second solvent and said high dielectric solvent is determined in accordance with the dielectric constants and viscosities of the second solvent and said high dielectric solvent.

17. (cancelled)

18. (cancelled)

19. (currently amended) The electrolyte of claim ~~17~~14, wherein a difference in the sulfur solubility between the first solvent and the second solvent is more than 20mM.

20. (original) The electrolyte of claim 14, wherein one of the solvents of said mixture is at least one selected from a group consisting of benzene, fluorobenzene, toluene, trifluorotoluene, xylene, cyclohexane, tetrahydrofuran, and 2-methyl tetrahydrofuran.

21. (original) The electrolyte of claim 14, wherein one of the solvents of said mixture is at least one selected from a group consisting of cyclohexanone, ethanol, isopropanol, dimethyl carbonate, ethylmethyl carbonate, diethyl carbonate, methylpropyl carbonate, methyl propionate, ethyl propionate, methyl acetate, ethyl acetate, propyl acetate, dimethoxy ethane, 1,3-dioxolane, diglyme (2-methoxyethyl ether), and tetraglyme.

22. (previously presented) The electrolyte of claim 14, wherein said high dielectric solvent is at least one selected from a group consisting of ethylene carbonate, propylene carbonate, γ -butyrolactone, and sulforane.

23. (cancelled)

24. (cancelled)

25. (cancelled)

26. (currently amended) The battery of claim 2337, wherein the mixture comprises first and second solvents, where a relative amount of the first and second solvents is determined in accordance with a relative amount of the sulfur and the sulfur compounds.

27. (original) The battery of claim 26, wherein a relative amount of the second solvent and the high dielectric solvent is determined in accordance with the dielectric constants and viscosities of the second solvent and the high dielectric solvent.

28. (cancelled)

29. (cancelled)

30. (currently amended) The battery of claim 2837, wherein the difference in the sulfur solubility between the first solvent and the second solvent is more than 20 mM.

31. (currently amended) The battery of claim 2337, wherein one of the solvents of the mixture is at least one selected from a group consisting of benzene, fluorobenzene, toluene, trifluorotoluene, xylene, cyclohexane, tetrahydrofuran, and 2-methyl tetrahydrofuran.

32. (currently amended) The battery of claim 2337, wherein one of the solvents of the mixture is at least one selected from a group consisting of cyclohexanone, ethanol, isopropanol, dimethyl carbonate, ethylmethyl carbonate, diethyl carbonate, methylpropyl carbonate, methyl propionate, ethyl propionate, methyl acetate, ethyl acetate, propyl acetate, dimethoxy ethane, 1,3-dioxolane, diglyme (2-methoxyethyl ether), and tetraglyme.

33. (currently amended) The battery of claim 2337, wherein the high dielectric solvent is at least one selected from a group consisting of ethylene carbonate, propylene carbonate, γ -butyrolactone, and sulforane.

34. (currently amended) An electrolyte for a lithium-sulfur battery having a positive and a negative electrode, comprising:
a first component solvent with a sulfur solubility greater than or equal to 20 mM;

a second component solvent with a sulfur solubility less than 20 mM ~~and greater than 0.5 mM~~;

a third component solvent having a high dielectric constant and a high viscosity and an electrolyte salt,

wherein

said first component solvent is substantially between 5% and 30% by volume of the electrolyte,

said second component solvent is substantially between 20% and 70% by volume of the electrolyte, and

said third component solvent is substantially between 20% and 70% by volume of the electrolyte.

35. (currently amended) An electrolyte for a lithium-sulfur battery having a positive and a negative electrode, comprising:

a first component solvent with a sulfur solubility greater than or equal to 20 mM;

a second component solvent with a sulfur solubility less than 20 mM ~~and greater than 0.5 mM~~;

a third component solvent having a high dielectric constant and a high viscosity; an electrolyte salt; and

an additive gas which forms a solid electrolyte interface (SEI) at a surface of the negative electrode during charging.

36. (currently amended) An electrolyte for use in a lithium-sulfur battery, comprising: a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;

a solvent having a high dielectric constant; and

an electrolyte salt,

wherein said mixture comprises:

a first solvent with a sulfur solubility greater than or equal to 20 mM; and

a second solvent with a sulfur solubility less than 20 mM ~~and greater than 0.5 mM~~, and

wherein:

the first solvent is substantially between 5% and 30% by volume of the electrolyte,
the second solvent is substantially between 20% and 70% by volume of the electrolyte, and
the solvent having a high dielectric constant is substantially between 20% and 70% by volume of the electrolyte.

37. (previously presented) A lithium-sulfur battery, comprising:
a negative electrode comprising a negative active material;
an electrolyte comprising:
a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;
a solvent having a high dielectric constant; and
an electrolyte salt; and
a positive electrode comprising a positive active material,
wherein said electrolyte further comprises an additive to prevent the formation of dendrite on a surface of said negative electrode.

38. (previously presented) A lithium-sulfur battery, comprising:
a negative electrode comprising a negative active material;
an electrolyte comprising:
a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;
a solvent having a high dielectric constant;
an electrolyte salt; and
an additive to form a solid electrolyte interface on a lithium metal surface of said negative electrode; and
a positive electrode comprising a positive active material.

39. (currently amended) A lithium-sulfur battery, comprising:
a negative electrode comprising a negative active material;
an electrolyte comprising:

a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;

a solvent having a high dielectric constant; and

an electrolyte salt; and

a positive electrode comprising a positive active material,

wherein the mixture comprises:

a first solvent with a sulfur solubility greater than or equal to 20 mM; and

a second solvent with a sulfur solubility less than 20 mM ~~and greater than 0.5 mM~~, and

wherein:

the first solvent is substantially between 5% and 30% by volume of said electrolyte,

the second solvent is substantially between 20% and 70% by volume of said electrolyte, and

the solvent having the high dielectric constant is substantially between 20% and 70% by volume of said electrolyte.